

Copper Prototype Testing Program

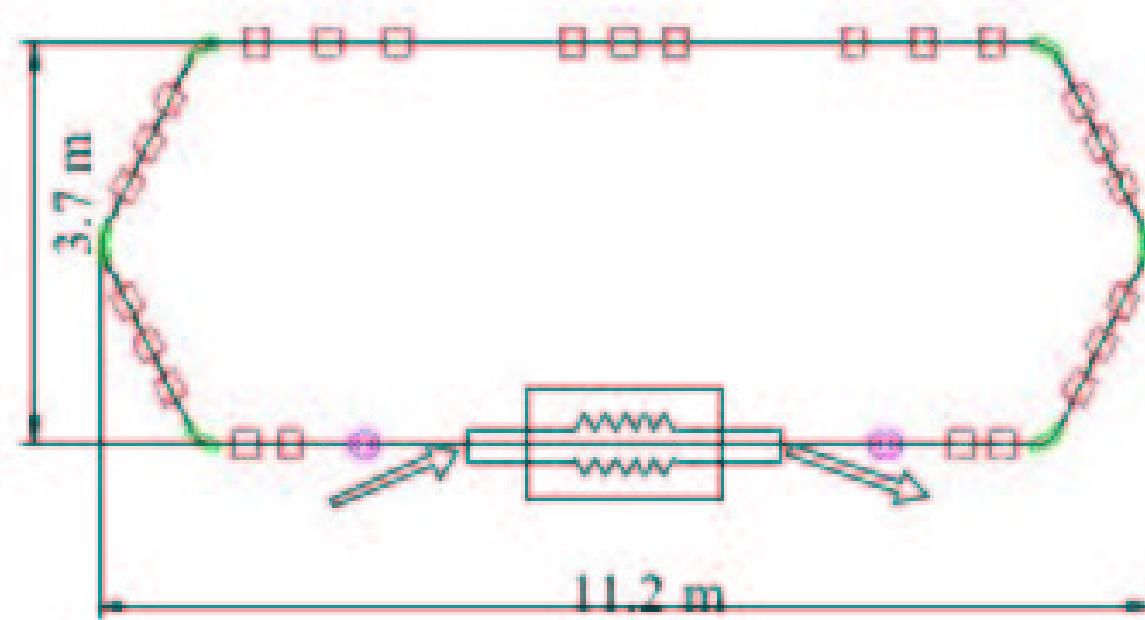
Rama Calaga

July 22, 2004



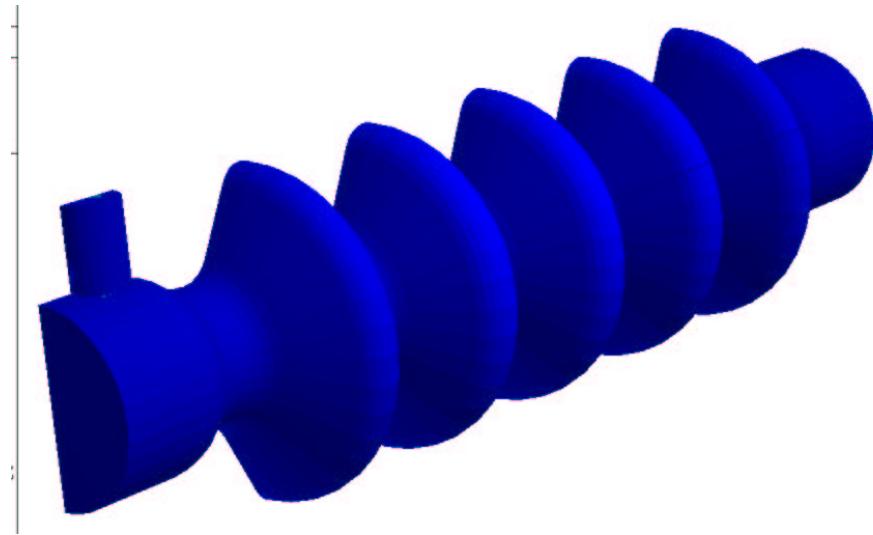
ERL Parameters

- Beam Energy - 20-40 MeV
- High bunch charge [10-20 nC], high average current [10-100mA]
- Rep rate \approx 9 MHz
- Energy recovery - 1 to 2 passes



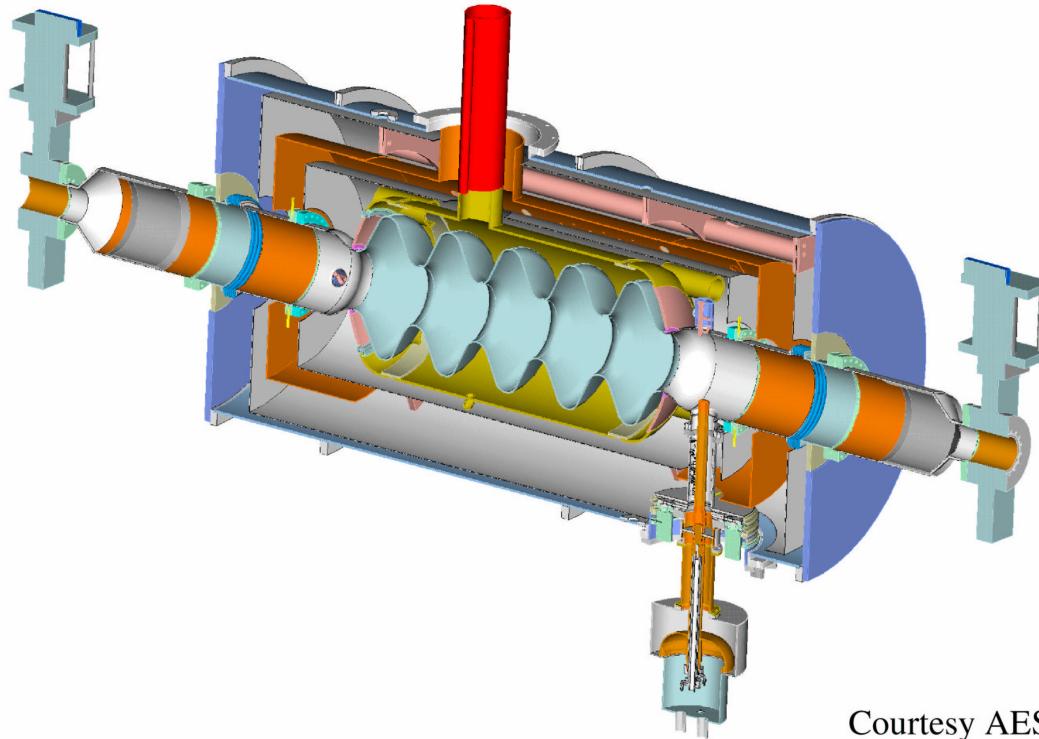
Cavity Parameters

- Frequency - 703.75 MHz
 - 25th harmonic of RHIC bunch repetition
 - Loss factor, CW power sources & cleaning
- 5 cell cavity structure
 - Fewer cells - fewer trapped modes
 - 17cm iris, 24 cm diameter (HOMs)
- Ferrite absorbers - HOMs
 - Broadband damping & water cooled



Diameter	17 cm	19 cm
Freq (MHz)	703.75	703.75
G (Ω)	225	200
R/Q (Ω)	807	710
Q BCS @ 2K	4.5×10^{10}	4×10^{10}
E_p/E_a	1.97	2.10
H_p/E_a (mT/MV/m)	5.78	5.94

Main Limitations of High Current SRF



Courtesy AES

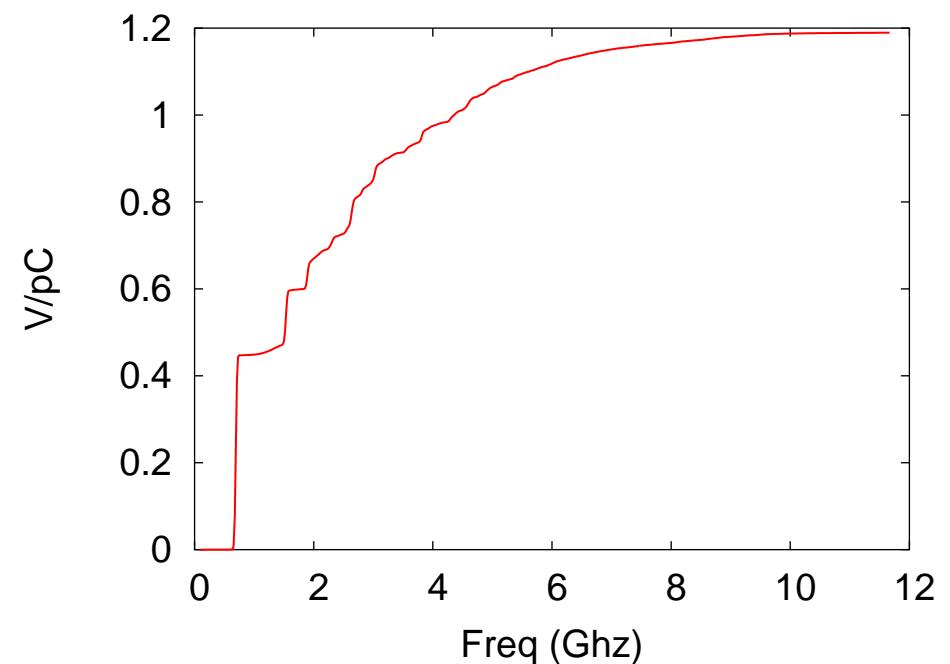
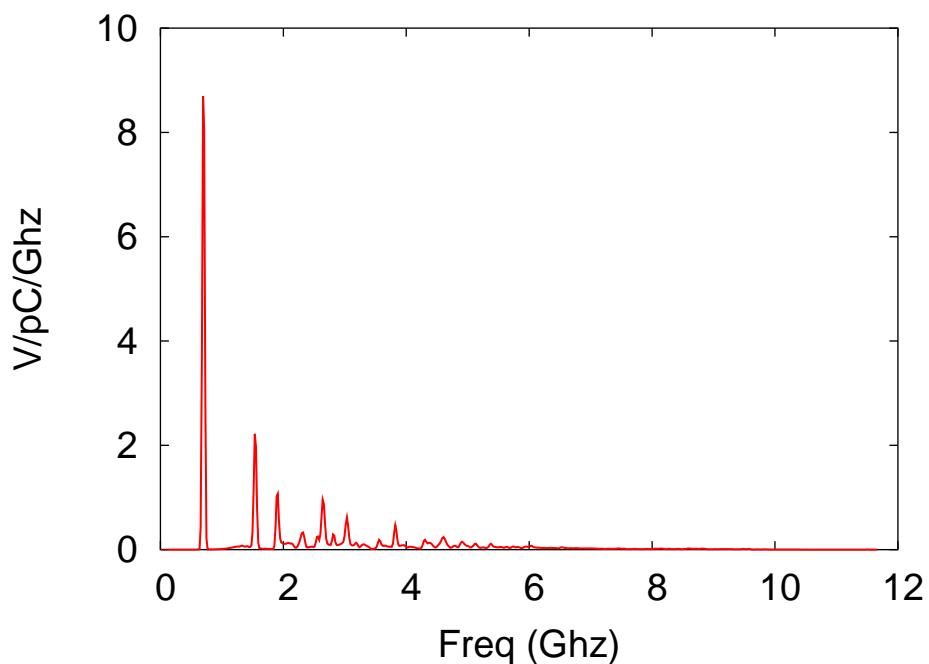
- Large HOM power - loss factor

$$P_{HOM} = f_b k q^2 \quad (1)$$

- Multibunch bunch instabilities - high Q HOMs

Power Lost Into HOMs

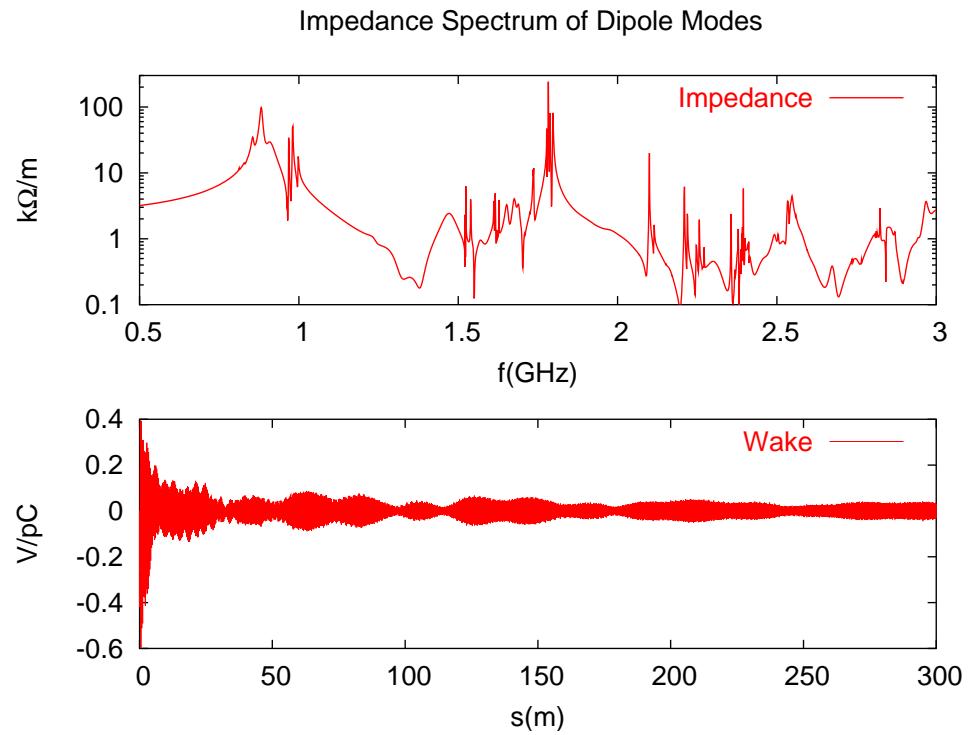
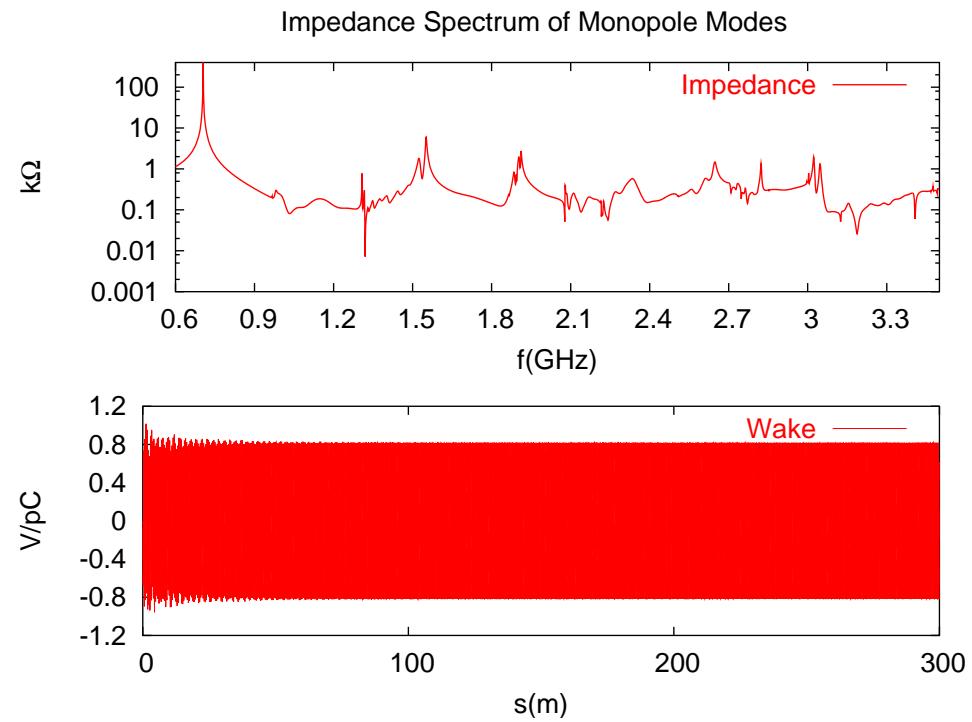
ABCI calculation using single bunch (bunch length-1cm).



Integrated loss factor - $1.2 \text{ V/pC} \approx 2\text{KW}$ of HOM power

Long Range Wakefields

Mafia 3D calculations using single bunch.



Transverse Beam Breakup

Multibunch instabilities giving rise to beam breakup:

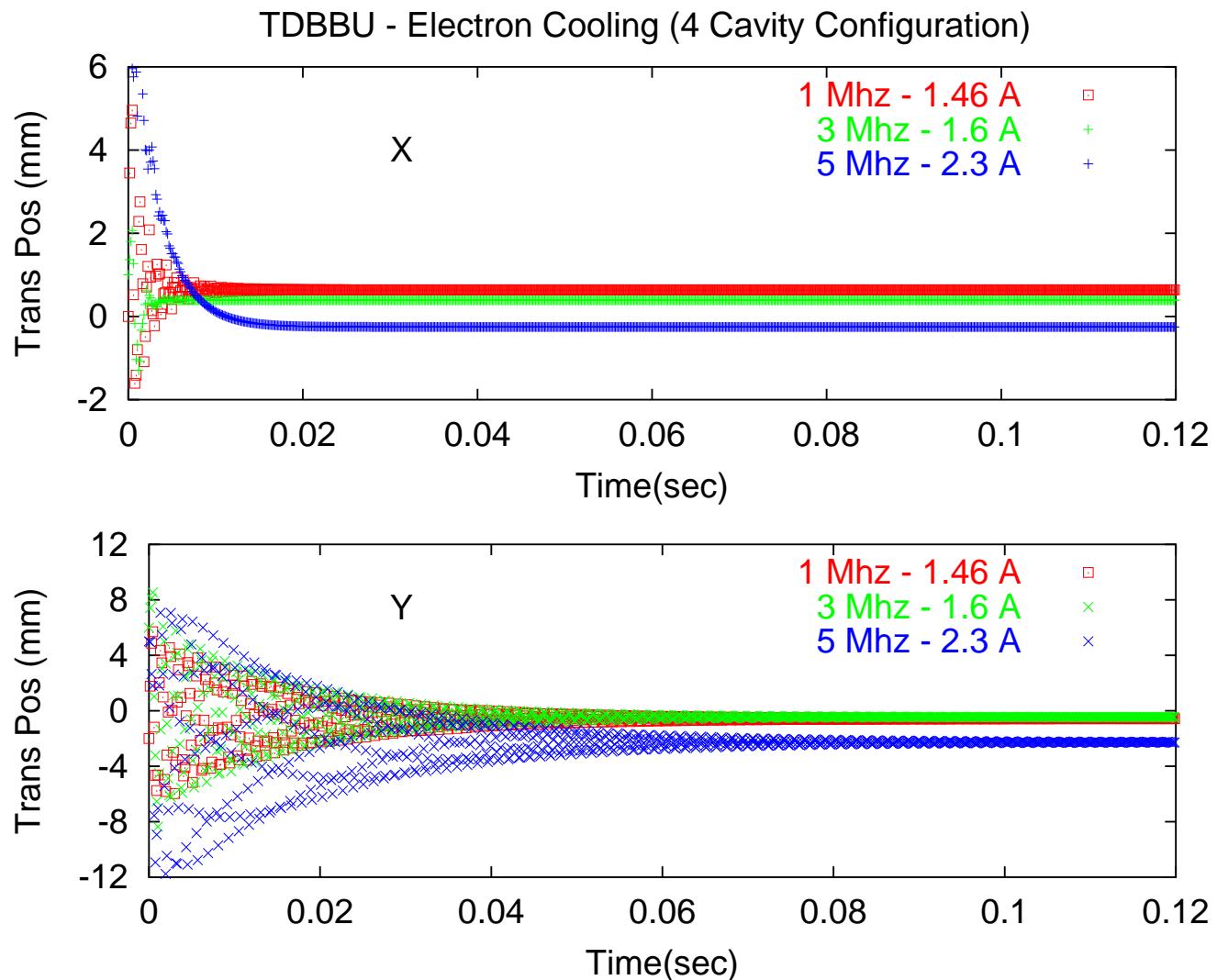
- High Q dipole modes
- Feedback loop between beam and cavities
- Worse for high current - high bunch charge

Threshold current for a simple case:

$$I_{th} = \frac{-2p_r c}{e(\frac{R}{Q})_m Q_m k_m M_{ij} \sin(\omega_m t_r) e^{\frac{\omega_m t_r}{2Q_m}}} \quad (2)$$

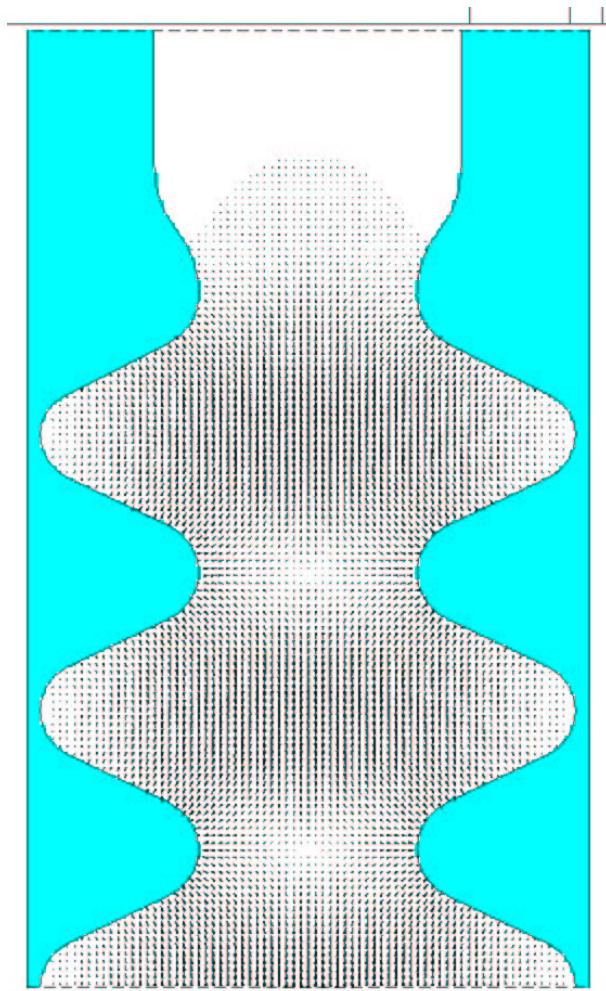
Numerical codes (**TDBBU & MATBBU**) for complex linac structures (**CASA - JLab**)

Numerical Simulations

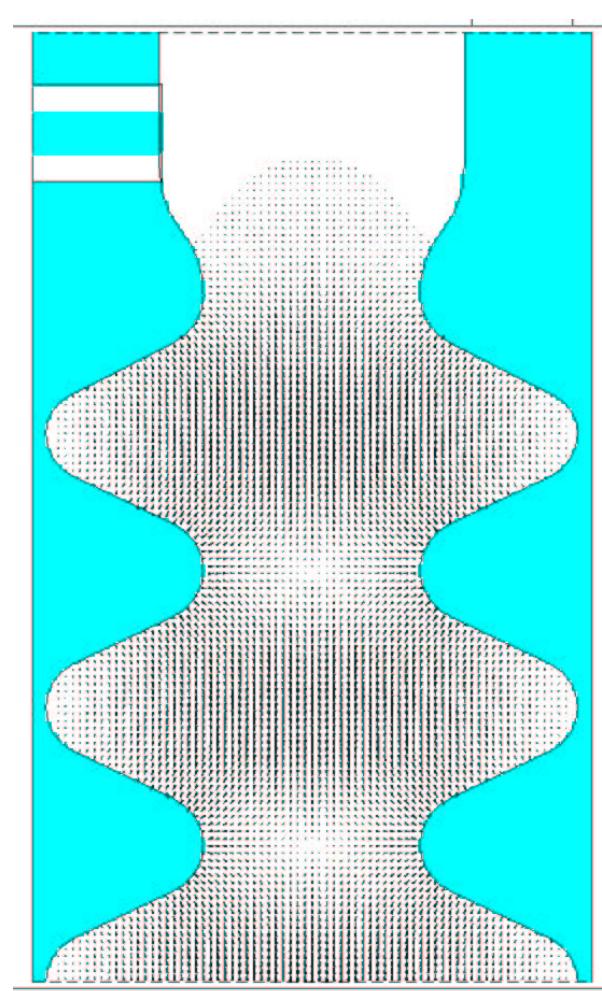


Transverse Kick due to FC Asymmetry

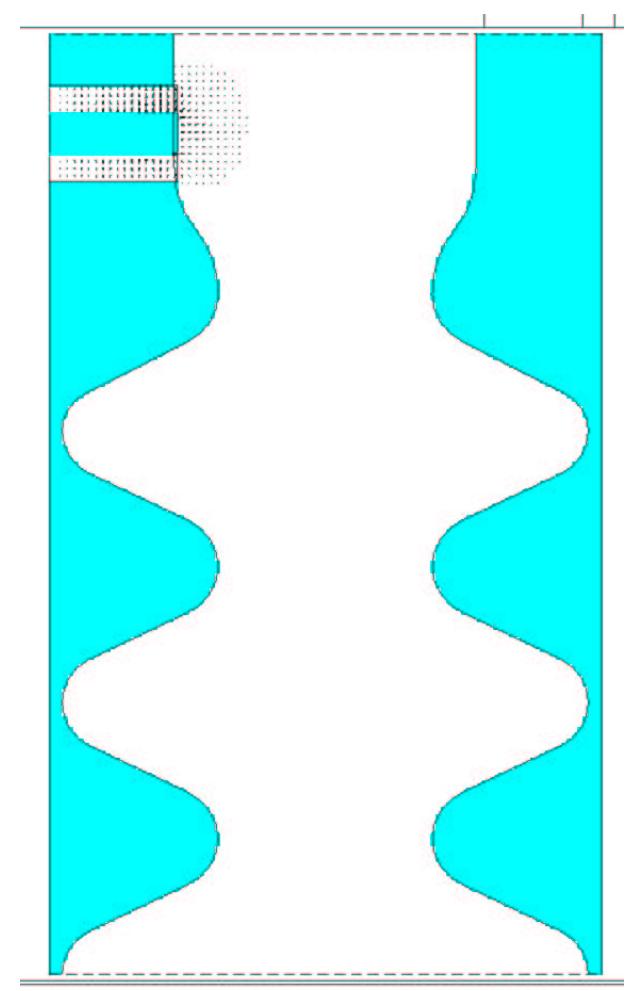
No Coupler



Fundamental Coupler

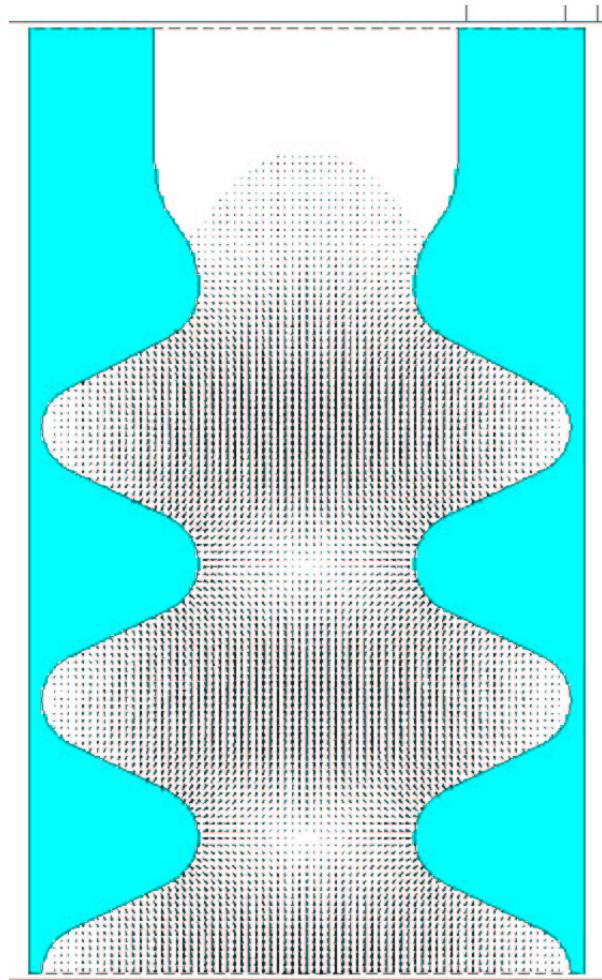


Difference Field

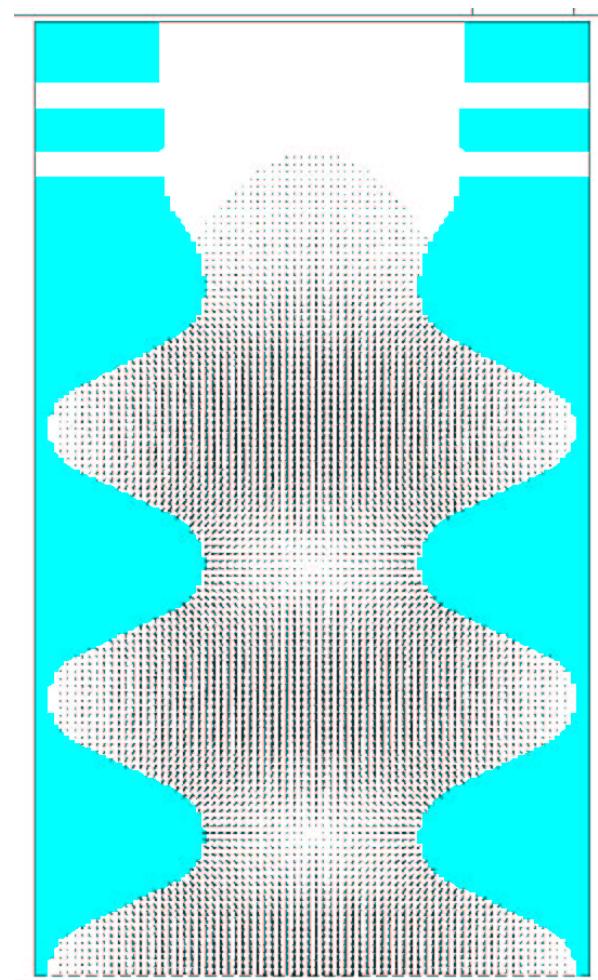


Transverse Kick due to 2 FC

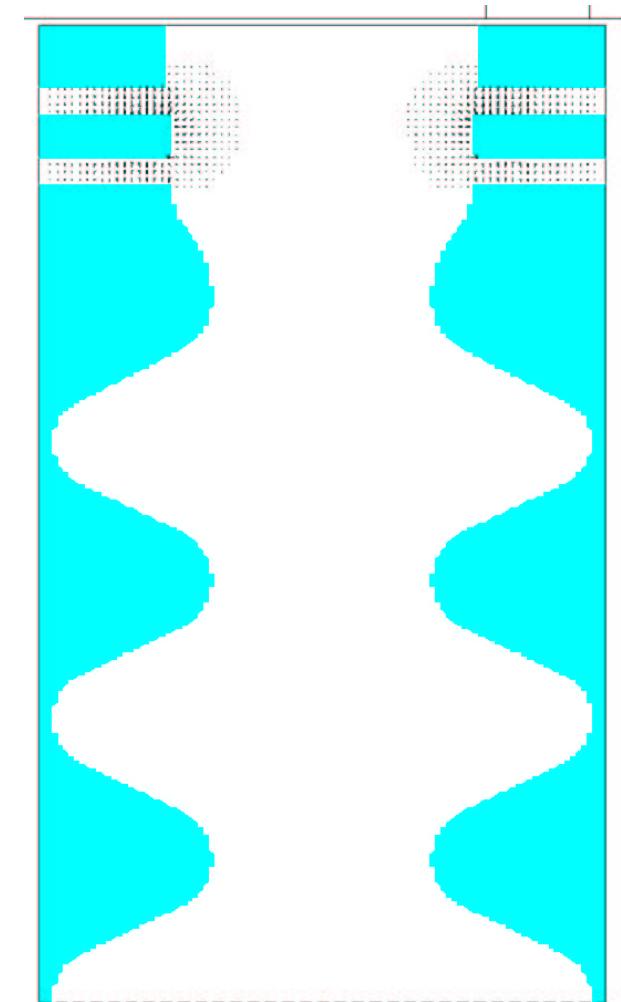
No Coupler



2 Fundamental Couplers



Difference Field



Calculation

Kick Factor:

$$v_t = \frac{V_{trans}}{V_{acc}} = \frac{\int (E_y + cB_x) dz}{\int E_z dz}$$

Kick received by the center of the bunch:

$$\alpha = \frac{p_t}{p} = \frac{eV_{acc}}{pc} Re(v_t e^{i\phi_0})$$

For Asymmetric Case:

$$v_t = 58.8 * 10^{-6}$$

$$kick \approx 60 \mu rad$$

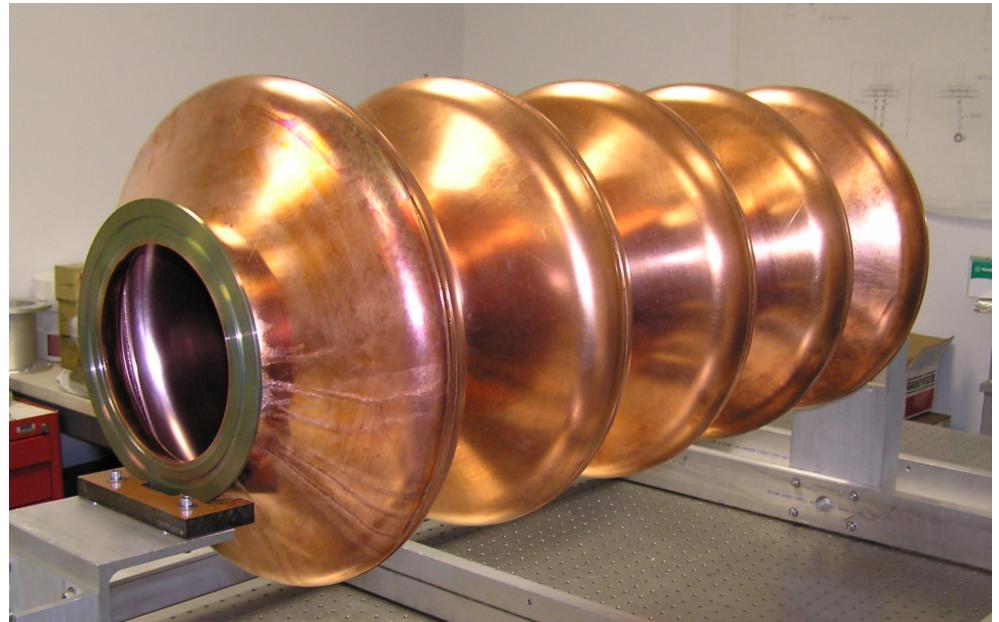
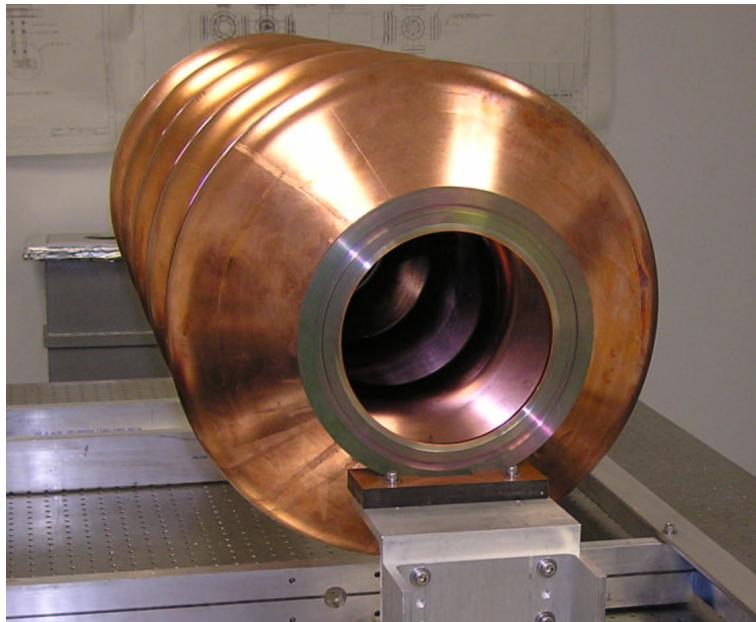
Symmetric Case:

$$v_t = 6.9 * 10^{-6}$$

$$kick \approx 7 \mu rad$$

Copper Prototype

End groups not shown here



Courtesy AES

Cu Test Program

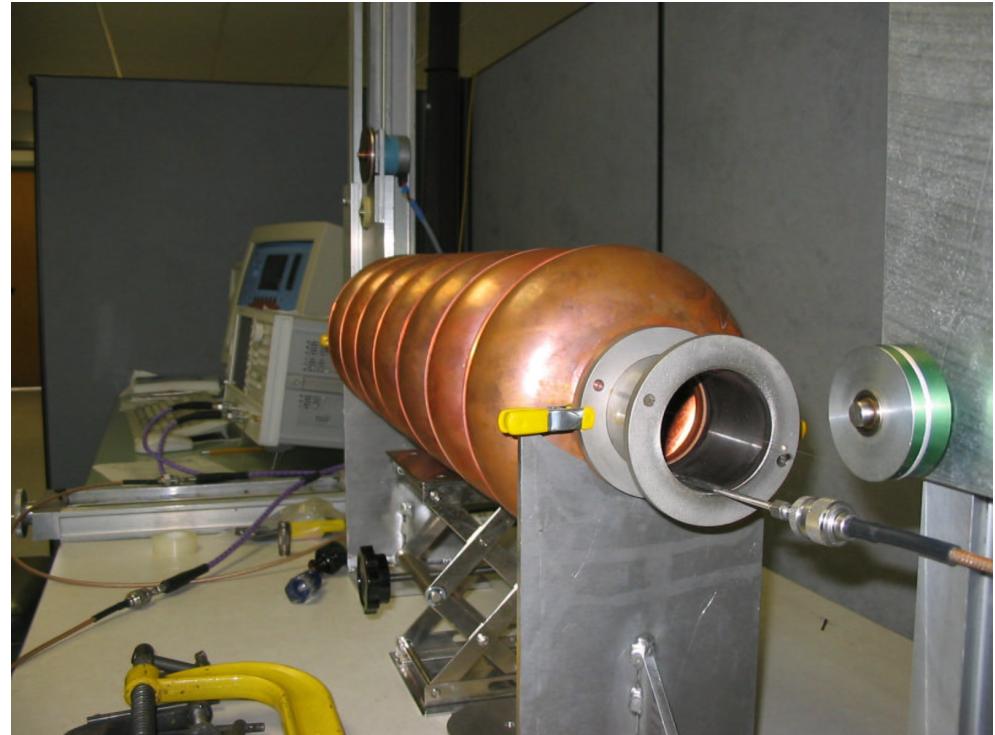
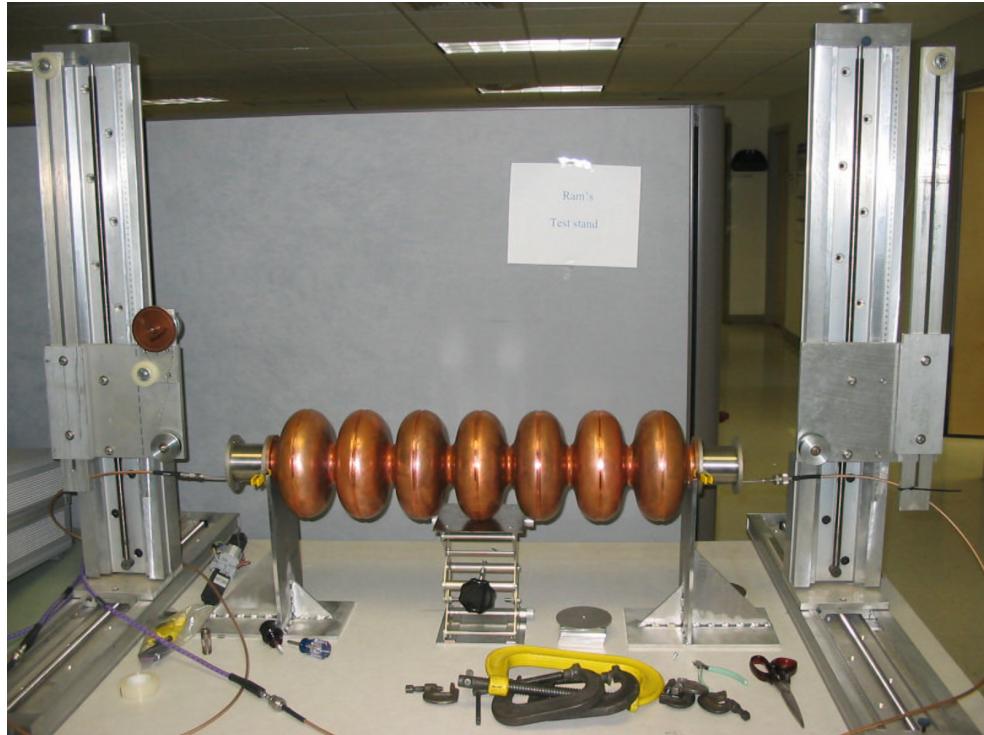
1. Measure freq's and Qs of fundamental and HOM modes [0.7-4GHz]
2. Bead-pull measurements to check fundamental mode field flatness
3. Identify the HOM modes from bead pull field profile.
4. Measure Qs after installing ferrite dampers and compare to MAFIA simulations
5. Measure damping from TESLA type HOM couplers.
6. Estimate FPC kick
7. Measure Superstructure...

Cu Model Test Stand



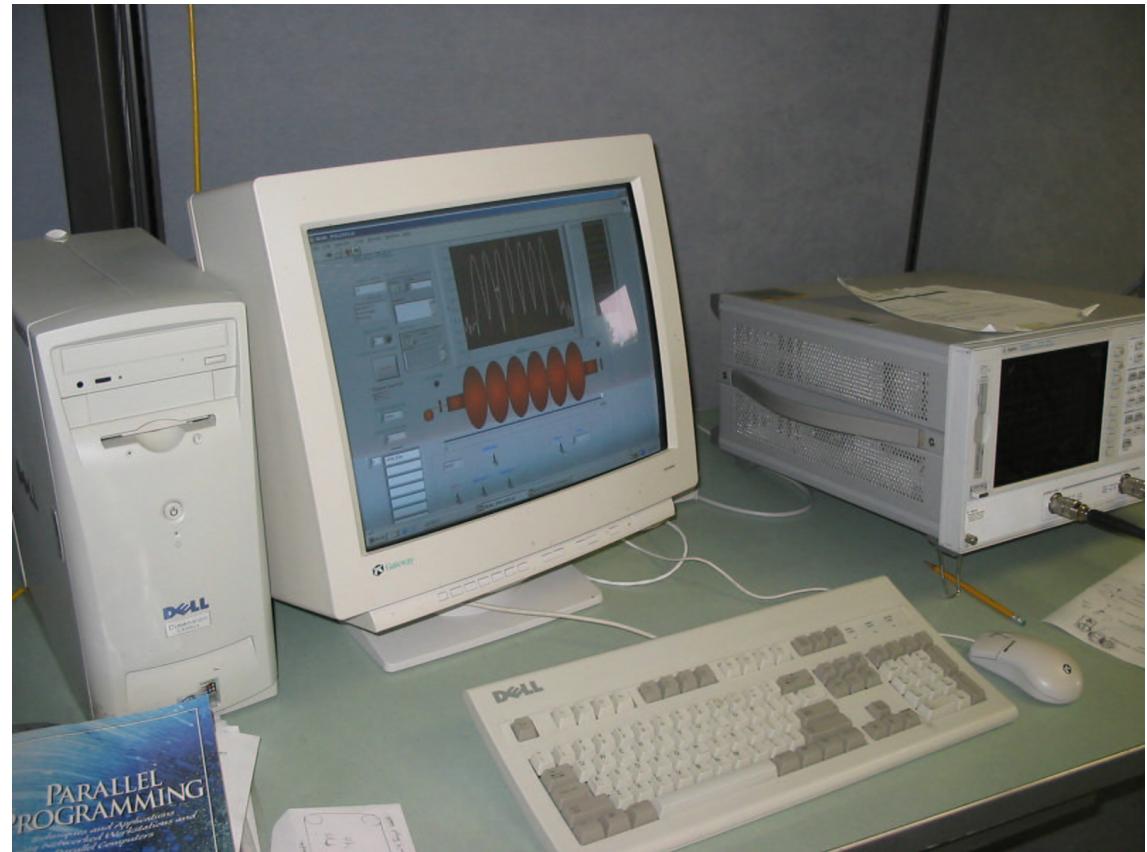
Bead Pull Setup

Field profile measurement using metallic/dielectric beads.



Higher Order Mode Measurements

HOM measurements using field symmetry.



Superstructure

- Design of 2X2 Super-Structure from existing model in collaboration with Jacek Sekutowicz (DESY)
- Calculations of SS modes and their characteristics
- BBU threshold limits for eRHIC type structures

